Development of a Methodology for Analysis of the Fe-56 ENDF-B/VI Cross Sections with a Time-of-Flight Experiment

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An accurate determination of the cross section data contained in the Evaluated Nuclear Data Files (ENDF) is vital in performing accurate particle transport simulations in a wide range of applications. This paper discusses a methodology developed for analysis of a time-of-flight (TOF) experiment performed for examination of iron cross sections. The methodology combines measurements from several experimental setups and corresponding Monte Carlo simulations.

The neutron TOF spectra were measured using the spherical-shell transmission method with iron shells of two different thicknesses and two neutron generating interactions for various beam angles. In this study we have considered N (p, n) and D (d, n) interactions for different beam angles including 0, 15, 30, 45, 60, 90, and 135 degrees. The experimental spectra were utilized to obtain a source distribution for Monte Carlo simulation of the iron shell experiments. Our results indicate that the angular distribution of the source reaction is very important for this work. The validity of this source distribution was tested.

Comparison between Monte Carlo predictions and TOF measurements identified discrepancies over several energy ranges that have been attributed to inaccuracies in the Fe-56 inelastic scattering cross section. To estimate the impact of the Fe-56 cross sections' inaccuracies on the measured spectra, we developed a utility code (XSMOD) for modifying the cross section data in the ENDF-B/VI library. XSMOD allows for any user-defined changes to cross section values at different energy ranges. Hence, using XSMOD, we modified the original ENDF-B/VI data, and performed Monte Carlo calculations to examine the predicted neutron spectra as compared with measured spectra.

Different cases in which the inelastic cross sections were decreased by various percentages in different energy ranges were examined. It was noted that the total cross section is accurate, hence as inelastic cross sections were changed, the elastic cross sections were changed oppositely so that the total cross section remained unchanged.

The results of these new calculations indicate that the modified cross sections yield significant reductions (as large as $\sim$40%) in the discrepancies between experimental and calculation spectra. This finding suggests that our methodology may be an effective approach for identifying regions of concern for cross section work. Further, a preliminary study using the multigroup form of the modified cross sections has shown significant impact on reactor pressure vessel fluences.

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